parasites by causing the pyriform stages to disappear quickly and also to cause the total disappearance of the parasites from the peripheral blood. The action was most noticeable on the pyriform stage found in the plasma, which is exactly analogous to the action of quinine in malaria. However, the drugs apparently reached the stages within the corpuscles, causing them to show signs of degeneration. They presented a ragged and irregular appearance, quite different from the normal.

In the experiments with trypanblau ten dogs suffering with piroplasmosis were utilized. Failure to cure the disease resulted in only three out of the ten cases. In the failures distemper and other factors probably contributed to the death of the animals. This is especially likely in view of the effect noted upon the morphology of the organism in the microscopical examinations. In one case, which was repeated successfully, an injection of trypanblau twenty-four hours after inoculation prevented the appearance of the parasites in the blood of the dog which remained perfectly well.

In a note appended to the paper we are informed that trypanblau exerts a very prompt effect on the parasites of splenetic fever. This effect is precisely similar to that on the organism of the dog disease with which the experiments were primarily concerned. It is thus permissible to assume that the agents used by Messrs. Nuttall and Hadwen may be of use in the treatment of this very important disease, as well as in others caused by similar organisms. We are informed that the authors have interested the Colonial Office and the Department of Agriculture and Fisheries in extensive practical tests. We are promised reports upon this work and upon further laboratory experiments at an early date.

The writer commends the paper as one of far-reaching importance. Moreover, it is a model in the treatment of an intricate subject. Full details of experiments are given so that the reader knows exactly what are the bases for the conclusions drawn.

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SPECIAL ARTICLES

DEMONSTRATIONS WITH THE MUSICAL ARC

The musical arc offers a convenient means of demonstrating many important features of electromagnetic theory. It may be of interest, therefore, to give a brief description of apparatus and methods, with references to some of the more elementary experiments which have been found helpful.

As is well known, the musical or "singing" arc[1] is obtained by connecting in parallel with the direct current arc a system containing self-induction and capacity. The arc used without this parallel or "secondary" system may be more or less unsteady, showing at the poles sudden change of potential difference of considerable magnitude. The secondary system may be thought of as supplying the conditions for taking up these fluctuations, and, in turn, emitting electric oscillations of frequencies determined in large part by the secondary itself. These oscillations, reacting on the arc, cause fairly regular interruptions in the discharge, which therefore emits a musical note. The pitch of this note may be varied by changing the conditions of the arc-circuit as well as by varying those of the secondary.

Examination by a revolving mirror and by the spectroscope seems to confirm what might from general considerations be expected in an arc of this kind, viz., that although the arc is interrupted, the poles give the distinctly different and characteristic forms of discharge observed in the continuous arc.[2]

For purposes of demonstration, good results may be obtained by using a condenser with capacity which may be varied from 1 to 10 microfarads and which is capable of standing a potential difference of 1,000 volts. The coil for the secondary may be made with three hundred turns of No. 15 annunciator wire wound on a spool of 10 cm. radius and 3 cm. axial length. The arc is perhaps most easily maintained between carbon poles. Examined

[1] Duddell, *Electrician*, 46, 1900. Simon, *Phys. Zeit.*, VII., 1906. Austin, *Bulletin of Bureau of Standards*, 3, No. 2, 1907.

[2] Vide *Astrophysical Journal*, XXVIII., No. 1, 1908.

in a revolving mirror, the musical arc shows serrations which are strongly marked near that pole which would be positive for the uninterrupted arc. Therefore to minimize the effects of convection as well as those due to wandering of the discharge over the terminals, and consequent change of pitch of the note, the poles should be about 8 mm. in diameter, vertical, and the positive one below.

With the above apparatus, the arc, after burning until the positive pole is sufficiently coned, may be made to give a clear note of tolerably uniform pitch and audible throughout a fairly large room.

Both pitch and intensity depend not only upon capacity, self-induction and resistance in the secondary, but also upon the potential difference of the arc terminals. High potentials give clearer tones, but the 110-v. circuit answers very well. For a given secondary, a slight adjustment of arc-length or of resistance in the arc-circuit may make a striking difference in the clearness and intensity of the note. Using the 110 V.D.C. mains, a current of 1.5 to 2.5 amperes is necessary. Too much current produces a hissing or an impure note, or even none at all. The fact that the tones may not be pure[3] does not interfere seriously with their use qualitatively as indicators of changes made in the various circuits employed. All connections should be very firmly made.

To show induced currents, incandescent bulbs may be used to advantage. Those of small resistance and for small potential difference are better, though of course easily burned out. Add to the above apparatus a few coils of various sizes, some metal plates, etc., and interesting demonstrations become at once possible. They depend on the change of pitch of the arc-note, or on the lighting up of incandescent lamps; these effects arising from modifications of the electrical conditions of secondary or tertiary circuits.

An obvious experiment is to vary the note by changes in the secondary, several octaves being easily obtained. This makes possible rough comparisons of self-inductions and of capacities for oscillatory currents, by comparing the arc-tones with those from tuning forks. The use of the ordinary formula, $2\pi\sqrt{LC}$ for the period of the discharge involves the assumption of its applicability, as well as the further one that the resistance may be neglected. It may readily be demonstrated that the latter is only approximately true.

The short-circuiting of the coil in the secondary produces a note the shrillness of which gives an instructive idea of the part played by inertia in an oscillating electrical system. An incandescent lamp may be made to light up by joining it with a coil laid on the one in the secondary circuit. Rotating and sliding the upper coil are modifications that suggest themselves at once. For oscillations of very high frequency, the bulb will not light up, since the heating effect varies inversely as the frequency, if the latter is high and the resistance is negligible. Placing a coil in open circuit on the one in the secondary produces no effect; but the result of closing the circuit of the upper coil is to raise the pitch of the note, the increased frequency of the oscillations arising from the decrease in effective self-induction in the oscillating system.

It is instructive to close the upper coil alternately through each of two equal resistances, one of which is non-inductive. The difference of pitch may be made very striking.

If two coils are used in series in the secondary, the effective loading of the oscillating circuit depends on the position of one coil relative to that of the other. The maximum inductance, and consequently the lowest note, is obtained when one coil lies upon the other so that the directions of their fields are the same. This contrasts sharply with the high note emitted when the fields oppose.

An iron plate laid on the coil in the secondary increases the inertia of the system and consequently lowers the pitch of the tone. In this way it may be shown that a soft iron plate changes the arc-tone more than a steel plate of equal thickness does. A plate of non-magnetic metal raises the pitch. Such a plate may be regarded as a series of closed

[3] Austin, *loc. cit.*

conductors. Interesting results may be brought out by comparing the effects of using solid metal plates and similar plates cut into sectors, insulated from one another. These results suggest the use of different forms of cores in a solenoid placed in series with the secondary circuit, or with the lamp and coil used to show induced currents.

The screening effects of conducting plates may be shown by placing them between the secondary coil and another coil in circuit with a lamp. For high frequencies, thin sheets of copper or of iron may cut down the brilliancy of the bulb very decidedly.

If a short-circuited coil is used instead of the plate, a similar screening effect may be shown.[4]

To show "resonance," arrange a second oscillating system containing capacity, self-induction, and a small lamp. If the coil of one system is laid upon that of the other, and the natural periods of the two systems are made approximately the same, the bulb lights up and the pitch of the note is changed. There is a considerable range of response in the second system, but with proper adjustment a maximum of light for varying frequencies may easily be observed. The use of two coils in series in this second oscillating system is convenient. One below the secondary coil and the other sliding on top of it makes the adjustment for maximum effect easier. The reaction of this new oscillating system on the secondary and thus on the arc may be very interestingly shown by making and breaking the new oscillating circuit while changing the capacity in the secondary circuit and noting the resulting change of pitch of the arc-note. The direction of this change depends on which of the two free periods is the greater.[5]

In conclusion it should be said that the above suggestions are made merely to call further attention to a means of demonstration which in some respects is simpler than the spark-discharge, and which has certain advantages over models.

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[4] Cf. J. J. Thomson, "Recent Researches," § 427.

[5] J. J. Thomson, "Recent Researches," § 432.

THE "ROCK WALL" OF ROCKWALL, TEXAS[1]

For many years reports of a more or less definite nature have been circulated describing the wonders of the ancient wall surrounding the town of Rockwall, Texas. The writer was able during the past winter to spend a few days investigating this supposed historic structure. It proves to be not a wall, but a number of disconnected sandstone dikes, strictly speaking, not surrounding the town, but trending in many directions. As exposures are few, they have been discovered in such scattered localities in the town's environs as to suggest the idea that they were fragments of a ruined wall.

Rockwall is located in a rich farming district about twenty-five miles east of Dallas. Black waxy soil covers the rolling hills, and only where erosion has been considerable can the underlying rocks be seen. These, when exposed, reveal blue limey strata of upper Cretaceous age in nearly horizontal attitude. A white clay, the decomposed product of the lime muds, generally occurs beneath the black soil. These lime muds are remarkable in their fredom from grit and in the peculiar property which causes them to decrepitate when exposed to the weather; notable also in that, on drying, cracks develop of various sizes. Within this series of semi-consolidated beds a few sandy layers occur. One is revealed by a drill record 1,800 $\pm$ feet below the surface; another may be seen near the town of Rockwall at the surface and consists of thinly bedded flaggy sandy limestone.

Though good exposures are infrequent, owing to the depth of soil, a peculiar condition affords ample opportunity to observe the dikes in place. These latter are natural courses for underground waters, and wells are often located on them. Though these walls are filled with water, the rock forming the dike, removed during the sinking of the well, may be examined at leisure.

The dikes are of various sizes, varying from an inch in thickness to eighteen inches or two feet. They stand vertically, or nearly so, and have in cases been followed downward fifty feet or more, always imbedded in the lime muds. They are composed of exceedingly fine-

[1] Published with the permission of the Director, U. S. Geological Survey.